



NFPA Roadmap Committee

Meeting Report on Customer Drivers

January 21, 2021

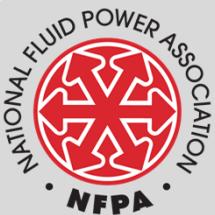
NFPA Technology Roadmap

The NFPA Technology Roadmap describes an industry-wide consensus regarding the pre-competitive research and development needs associated with improving the design, manufacture, and function of fluid power components and systems.

The research and development agenda it describes is focused on advancements that will help the fluid power industry meet the future needs of its customers, expand into new markets, and attract the best and brightest students to the field.

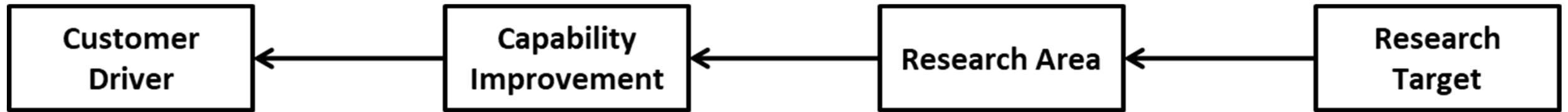
It is used by the NFPA and its academic partners to guide their research efforts, by NFPA members and other industry players to inform decisions about research partnerships and product development, and by academic, government, and other organizations that wish to pursue research and development projects of importance to the fluid power industry.

It is updated every two years under the guidance and leadership of the NFPA Roadmap Committee.



Roadmap Elements

The NFPA Technology Roadmap is comprised of the following four elements, each linked to the one preceding in an interdependent chain.

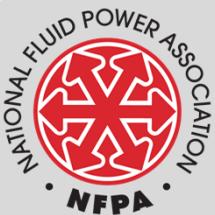


Customer Drivers are the business or technology objectives of fluid power customers. They help them serve the needs of their own customers, and are not necessarily connected to their use of fluid power.

Capability Improvements describe the ways in which fluid power systems must improve if they are to meet or better meet the customer needs described by the Customer Drivers.

Research Areas are the broad areas of pre-competitive investigation that could assist in bringing about the Capability Improvements.

Research Targets are the objectives that quantify or otherwise describe successful strategies for pursuing the Research Areas.



2021 Roadmap Process and Timeline

The NFPA Roadmap Committee is following this process and timeline for the 2021 update to the NFPA Technology Roadmap. This is the report from its meeting on January 21, 2021 to discuss, define and prioritize customer drivers.

Phase 1 – Customer Drivers

- Nov 12 Launch of survey on customer drivers
- Dec 17 Deadline to respond to survey on customer drivers
- Jan 21 Virtual committee meeting to discuss, define and prioritize customer drivers

Phase 2 – Capability Improvements

- Jan 28 Meeting report sent with prioritized customer drivers and setting the stage for fluid power alignment and capability improvements
Launch of survey on fluid power alignment and capability improvements
- Feb 18 Deadline to respond to survey on fluid power alignment and capability improvements
- Mar 4 Virtual committee meeting at NFPA Regional Conference to discuss, define and prioritize capability improvements

Phase 3 – Research Areas and Targets

- Mar 11 Meeting report sent with prioritized capability improvements and setting the stage for research areas and targets, including process for defining working groups for each capability improvement
Launch of survey on research areas and targets
- Apr 1 Deadline to respond to survey on research areas and targets
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Phase 4 – Final Roadmap Document

- Jun Draft Roadmap document written
- Jul 8 Draft Roadmap document sent for review and comment
- Jul 22 Deadline to return comments on draft Roadmap
- Aug 17 Final Roadmap document presented at NFPA IEOC

Meeting Participants

Committee Chair

- Mike Betz, Danfoss

Committee Vice Chair

- Bradlee Dittmer, IMI

Committee Members

- Brian Rhode, Afton Chemical
- Blake Cawley, AMETEK
- Ada Leung, Anfield Sensors
- Benjamin Moses, Association for Manufacturing Technology
- Cory Geers, BDI
- Kent Sowatzke, Bimba
- Jon Frey, Bosch Rexroth
- Christian Eitel, Bucher Hydraulics
- Jeff Watts, Bucher Hydraulics
- Todd Harmon, Canfield Industries
- Jeff Ayers, CIM-TEK Filtration
- Michael DeFrancesco, Classic Coil Company
- Lane Boger, Comer Industries
- Zach Christenson, Continental ContiTech
- Raffaele Invrea, Continental Hydraulics
- Dominic Catanzarite, Daman Products
- Matt Giloth, Daman Products
- Kevin Lingenfelter, Danfoss
- Jason Palmer, Delta Computer Systems
- Jerry Weber, Delta Power
- Ivan Sheffield, Des-Case
- Chris Heczko, Dura-Bar
- Jason Parr, Dura-Bar
- Adam Livesay, Elevat IoT
- Robert Haun, Emerson/ASCO/Aventics
- Jonathan Gamble, Enfield Technologies
- Ben Wallis, eShipping
- Joel Edwards, Faster

- Mitchell Wiese, Faster
- Mike Guelker, Festo
- Bert Martinez, Fluid Power Concepts
- Matt Loeffler, FORCE America
- Todd Pinkelman, Gates Corporation
- Derrick Dunn, Geartek
- Mark Paxton, HANSA-FLEX
- Mark Bokorney, Hydra-Power Systems
- Scott Nagro, HydraForce
- Russ Schneidewind, HydraForce
- Narendra Gupta, Hyster-Yale
- Rex Wetherill, IoT Diagnostics
- Brian Steward, Iowa State University
- Mitchell Baker, JARP Industries
- Joe Jackan, JARP Industries
- Jeff Bauer, John Deere
- Paul Marvin, John Deere
- Tom VanderMeulen, Kawasaki Hydraulics
- Gary Dostal, Komatsu
- Brian Thiel, Komatsu
- Patrick Green, Kraft Fluid Systems
- Paul Michael, Milwaukee School of Engineering
- Tom Wanke, Milwaukee School of Engineering
- Ari Almqvist, Moog
- Bob Mosey, Moseys Production Machinists
- Alan McCay, Motion Industries
- Larry Wesley, Muncie Power Products
- Bob Bates, National Tube Supply
- Gary Throw, National Tube Supply
- Rob Wuertz, OEM Controls
- Darren Nowicki, Pall Corporation
- Brad Bomkamp, Parker Hannifin
- Ron Zielinski, PolyMod Technologies
- Jose Garcia Bravo, Purdue University
- Royal Bush, Royal Systems Group

- Jason Looman, Scanreco
- Kevin Smith, Scott Industrial Systems
- Allan Stutz, Sharon Tube
- Scott McCambridge, SMC Corporation of America
- Jeff Andrasik, Smithers
- Steve Meislahn, Sun Hydraulics
- Keith Bayer, SunSource
- Mike Terzo, Terzo Power Systems
- Zeke Metzler, Texcel Ribber
- Andrew Zaske, Tolomatic
- Rob Zesch, TraceParts
- Michael Cook, Trelleborg Sealing Solutions
- Beth Figliulo, Trelleborg Sealing Solutions
- Nancy Getz, Trelleborg Sealing Solutions
- Johannes Kunze, Trelleborg Sealing Solutions
- John McLaughlin, Trelleborg Sealing Solutions
- Tom Zozokos, Trelleborg Sealing Solutions
- Ashlie Martini, University of California-Merced
- Kim Stelson, University of Minnesota
- Jim Van de Ven, University of Minnesota
- Scott Jones, Womack Machine Supply

NFPA Staff

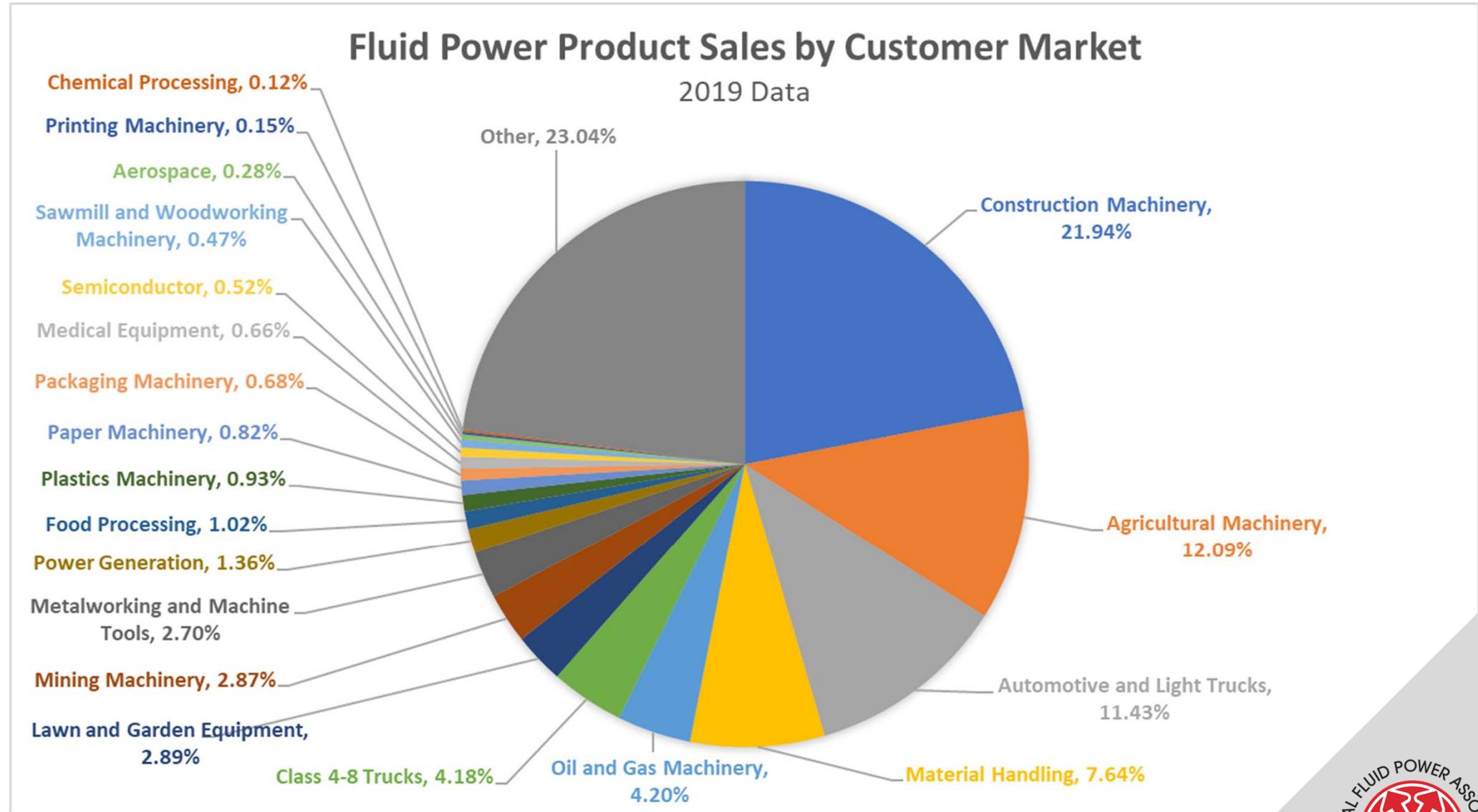
- Pete Alles
- Eric Lanke
- Maddie Parise



Fluid Power Customer Markets

The Committee first reviewed the 20 largest fluid power customer markets.

Fluid power technology is used in hundreds of applications in dozens of specific customer markets. Generally speaking, all of fluid power's customer markets can be grouped into two general areas: those that are served by hydraulics and those that are served by pneumatics. According to NFPA's latest data, the 20 largest customer markets represent nearly 77% of all hydraulic and pneumatic product sales.



Customer Drivers

The Committee next reviewed the Customer Drivers that were defined as part of the 2019 NFPA Technology Roadmap.

Customer Drivers are the business or technology objectives of fluid power customers. Generally speaking, fluid power customers are the companies that build machines that incorporate fluid power components and systems. We sometimes refer to these customers as “machine builders.” The Customer Drivers help these machine builders serve the needs of their own customers (the companies or people that purchase and use the machines) and are not necessarily connected to their use of fluid power.

In the 2019 NFPA Technology Roadmap, the following eight Customer Drivers were identified as those of highest importance to the majority of fluid power customer markets:

Customer Drivers

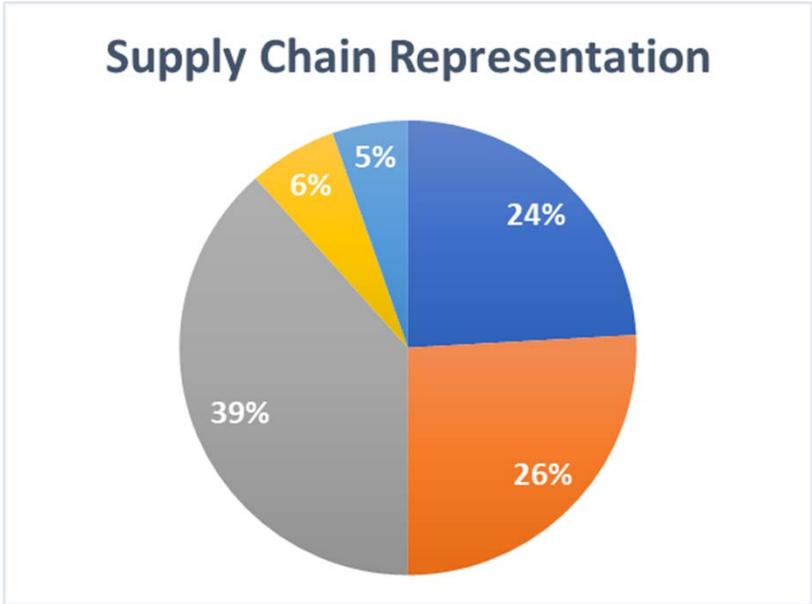
Fluid power’s machine builders want to provide their customers with machines that offer:

1. Increased availability and up-time
2. Increased productivity and performance
3. Compliance with safety regulations and machine directives
4. Lower capital and operating costs
5. Easier and more predictable maintenance
6. Greater integration of technologies, including data acquisition, utilization, and ownership
7. Weight reductions and increased power density
8. Autonomous operation

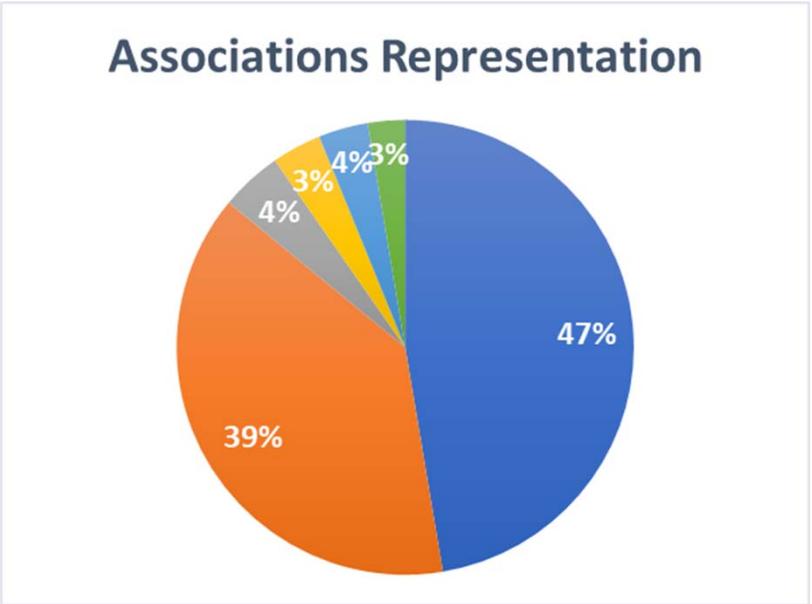


Survey on Drivers in Fluid Power Customer Markets

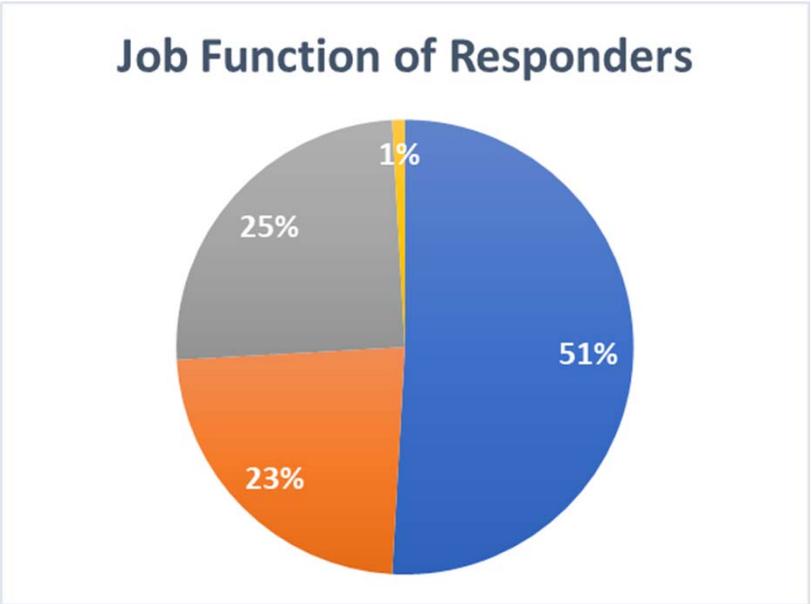
The Committee next reviewed the results of a December 2020 survey conducted by NFPA to determine the importance of these Customer Drivers in the 20 largest fluid power customer markets, and to determine if any new drivers had emerged in these markets since the time of the 2019 NFPA Technology Roadmap. The survey received responses from 113 individuals across the fluid power supply chain, including a large percentage from the NFPA Roadmap Committee.



■	SUPPLIER to the fluid power industry
■	MANUFACTURER of fluid power components
■	Fluid power DISTRIBUTOR or system integrator
■	MACHINE BUILDER that uses fluid power technology
■	USER of machines that use fluid power technology



■	National Fluid Power Association
■	Association for High Technology Distribution
■	Power Transmission Distributors Association
■	Packaging Machinery Manufacturers Institute
■	Association of Equipment Manufacturers
■	Association for Manufacturing Technology



■	Executive Management
■	Sales or Marketing
■	Engineering
■	Human Resources



Importance of Existing Customer Drivers

CUSTOMER MARKETS	N	CUSTOMER DRIVERS							
		Increased availability and up-time	Increased productivity and performance	Compliance with safety regulations and machine directives	Lower capital and operating costs	Easier and more predictable maintenance	Greater integration of on-board technologies, including optimal data acquisition, utilization, and ownership protocols	Autonomous operation	Weight reductions and increased power density
Aerospace	28	3.929	3.643	4.464	3.214	3.500	3.607	3.143	3.464
Agricultural Machinery	58	4.362	4.276	3.966	3.966	3.672	3.569	3.293	3.293
Automotive and Light Trucks	34	4.294	4.265	4.176	3.824	3.735	3.647	3.029	3.353
Chemical Processing	19	4.579	4.368	4.368	3.632	3.526	3.737	2.842	2.421
Class 4-8 Trucks	10	4.400	4.200	4.500	4.400	4.000	3.700	3.300	4.000
Construction Machinery	47	4.574	4.574	4.319	4.021	3.830	3.553	3.277	3.532
Food Processing	37	4.595	4.514	4.459	4.027	3.892	3.459	2.919	2.703
Lawn and Garden Equipment	15	4.200	4.000	3.933	4.133	3.467	2.867	3.200	3.000
Material Handling	51	4.451	4.471	4.216	3.980	3.784	3.647	3.392	3.235
Medical Equipment	17	4.412	4.235	4.765	3.471	3.647	4.118	3.412	3.000
Metalworking and Machine Tools	41	4.585	4.634	4.220	3.878	3.951	3.805	3.317	2.854
Mining Machinery	29	4.586	4.552	4.414	3.966	3.966	3.828	3.621	3.138
Oil and Gas Machinery	26	4.731	4.500	4.654	3.885	3.885	3.769	3.346	2.962
Packaging Machinery	33	4.697	4.697	4.333	4.121	4.121	4.182	3.697	3.152
Paper Machinery	25	4.760	4.680	4.360	4.240	4.160	3.920	3.200	2.800
Plastics Machinery	25	4.640	4.640	4.240	4.160	4.160	3.800	3.360	3.000
Power Generation	21	4.762	4.429	4.524	3.952	3.905	4.095	3.476	3.000
Printing Machinery	9	4.778	4.778	4.667	4.222	4.333	4.000	3.667	3.333
Sawmill and Woodworking Machinery	21	4.429	4.714	4.429	3.905	3.952	3.048	2.857	2.762
Semiconductor	5	4.600	4.600	4.600	4.200	3.600	4.000	3.600	4.000
All Responses	551	4.506	4.441	4.321	3.938	3.848	3.695	3.281	3.122

Respondents were asked to rank the importance of each Customer Driver in each of the customer markets with which they were familiar. Some variations in importance emerged for particular markets. In the aggregate, all the drivers were ranked as at least somewhat important, with “Increased availability and up-time” ranked highest and “Weight reductions and increased power density” ranked lowest.

Based on these results, it was decided that all eight of the existing drivers should be considered for inclusion in the 2021 NFPA Technology Roadmap.

Rank how important each of the customer drivers are in each of the customer markets.

- 5 = Extremely important
- 4 = Very important
- 3 = Somewhat important
- 2 = Not so important
- 1 = Not at all important



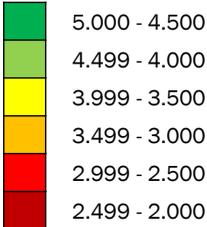
Customer Drivers – Hydraulic vs. Pneumatic Markets

CUSTOMER MARKETS	N	CUSTOMER DRIVERS							
		Increased availability and up-time	Increased productivity and performance	Compliance with safety regulations and machine directives	Lower capital and operating costs	Easier and more predictable maintenance	Greater integration of on-board technologies, including optimal data acquisition, utilization, and ownership protocols	Autonomous operation	Weight reductions and increased power density
Agricultural Machinery	58	4.362	4.276	3.966	3.966	3.672	3.569	3.293	3.293
Automotive and Light Trucks	34	4.294	4.265	4.176	3.824	3.735	3.647	3.029	3.353
Construction Machinery	47	4.574	4.574	4.319	4.021	3.830	3.553	3.277	3.532
Material Handling	51	4.451	4.471	4.216	3.980	3.784	3.647	3.392	3.235
Oil and Gas Machinery	26	4.731	4.500	4.654	3.885	3.885	3.769	3.346	2.962
Top 5 Hydraulic Markets	216	4.463	4.412	4.218	3.949	3.769	3.620	3.301	3.278
Automotive and Light Trucks	34	4.294	4.265	4.176	3.824	3.735	3.647	3.029	3.353
Food Processing	37	4.595	4.514	4.459	4.027	3.892	3.459	2.919	2.703
Medical Equipment	17	4.412	4.235	4.765	3.471	3.647	4.118	3.412	3.000
Packaging Machinery	33	4.697	4.697	4.333	4.121	4.121	4.182	3.697	3.152
Semiconductor	5	4.600	4.600	4.600	4.200	3.600	4.000	3.600	4.000
Top 5 Pneumatic Markets	126	4.516	4.460	4.397	3.929	3.865	3.810	3.087	3.246
All Responses	551	4.506	4.441	4.321	3.938	3.848	3.695	3.281	3.122

When comparing responses for the top 5 hydraulic markets to the top 5 pneumatic markets, not much variation emerges – either from each other or from the aggregate of all responses.

Based on these results, it was decided to move forward with a single set of customer drivers for all fluid power customer markets. A Technology Roadmap developed from that foundation will be of greatest use to the greatest number of stakeholders.

Rank how important each of the customer drivers are in each of the customer markets.
 5 = Extremely important
 4 = Very important
 3 = Somewhat important
 2 = Not so important
 1 = Not at all important



Suggestions for New Customer Drivers

In addition to ranking the importance of the existing Customer Drivers, respondents were asked to suggest any additional Drivers that they would have ranked as “Extremely Important” or “Very Important” for the customer markets with which they were familiar. Here’s a summary of the responses collected, sorted by market, with the percent of the fluid power market that each represents.

Aerospace (0.28%)

Long life

Agricultural Machinery (12.09%)

On-time delivery within the prescribed time window

Compliance with environmental regulations

Financing

Construction Machinery (21.94%)

On-time delivery within the prescribed time window

System and energy efficiency

Connected intelligence

Automation of implement function is more important than autonomy

On-board diagnostics access

Lawn and Garden Equipment (2.89%)

On-time delivery within the prescribed time window

Material Handling (7.64%)

Connected intelligence

Metalworking and Machine Tools (2.70%)

IoT, Connected intelligence

Oil and Gas Machinery (4.20%)

Reduced emissions/electrification

Business cycles

Power Generation (1.36%)

IoT, Connected intelligence

Sawmill and Woodworking Machinery (0.47%)

Environmental compliance



Action on Suggested Customer Drivers

Noting several commonalities among the suggested customer drivers, especially among those that impact large segments of the fluid power market, the Committee identified the following suggested drivers for discussion and action.

Suggested Driver	Market Weight	Discussion Summary and Action
On-time delivery within the prescribed time window	36.92%	Two concepts were discussed: (1) "Lead time," i.e., decreasing the lead time for the user to receive the machine, and (2) "On-time delivery," i.e., user consistently receiving the machine when promised. It was recognized that both could support the machine's availability and up-time (an existing driver) but were likely better positioned as separate drivers. It was also recognized that both may be supply chain rather than technology challenges, and therefore not likely to result in specific action on the Technology Roadmap. It was decided to test the importance of the two concepts (lead time and on-time delivery) on the upcoming survey designed to prioritize the final customer drivers and to develop initial fluid power capability improvements to address them.
Connected intelligence	33.64%	It was recognized that "Connected intelligence" is a mechanism that can meet the needs described by many of the existing drivers, including increased availability, increased productivity, compliance with safety regulations, easier maintenance, and autonomous operation. It was also recognized that the need to provide users with machine data is and can be a driver in and of itself, as currently described by the existing driver focused on providing greater integration of technologies. It was decided to re-word that driver to read: "Increased use of integrated data and connected intelligence," and to re-test its importance on the upcoming survey.
System and energy efficiency	21.94%	It was recognized that "Energy efficiency" is a mechanism that can meet the needs described by some of the existing drivers, including increased productivity and lower operating cost. It was also recognized that efforts to increase energy efficiency on a machine could also lower productivity and performance, and that there were some applications where the drive for energy efficiency could outweigh those performance concerns. As such, it was decided to add "Increased energy efficiency" as a driver, recognizing that users could obtain that objective at the machine, system and/or component level.
Automation of implement function is more important than autonomy	21.94%	It was decided to reword the existing driver on this subject to read: "Autonomous functions and operation."
On-board diagnostics access	21.94%	It was decided that "On-board diagnostics access" was well aligned with the re-worded driver: "Increased use of integrated data and connected intelligence," and that no further edits to the re-worded driver were necessary.
Compliance with environmental regulations/reduced emissions/electrification	12.56%	Multiple concepts were discussed. The need for OEMs to provide users with machines that comply with environmental regulations and that have reduced emissions was recognized. As such, it was decided to re-word an existing driver to read: "Compliance with environmental and safety regulations and machine directives." The concept of "Electrification" was recognized as an important mechanism to meet the needs expressed by some of the existing drivers. It was decided not to add it as a driver in and of itself.



Draft List of 2021 Customer Drivers

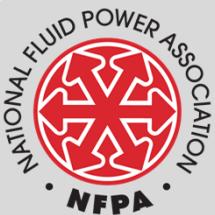
To summarize the discussions and actions taken by the Committee, the following represents the draft list of Customer Drivers that will be used in the further development of the 2021 NFPA Technology Roadmap (not in priority order).

Fluid power's machine builders want to provide their customers with machines that offer:

- Increased availability and up-time
- Decreased lead time in getting the machine
- On-time delivery of the machine
- Increased productivity and performance
- Increased energy efficiency
- Compliance with environmental and safety regulations and machine directives
- Lower capital and operating costs
- Easier and more predictable maintenance
- Increased use of integrated data and connected intelligence
- Autonomous functions and operation
- Weight reductions and increased power density

It was agreed that this list of drivers would be included on the upcoming survey designed to prioritize the final customer drivers and to develop initial fluid power capability improvements to address them.

Recognizing that several interdependent relationships exist among the drivers, and that some can be seen as methods for addressing the needs expressed by others, it was requested that the survey be structured in such a way to solicit ideas for how these relationships can best be described and used most effectively in the development of the Technology Roadmap.



Wrap-Up and Next Steps

The Committee meeting closed with a review of the next steps on the process and timeline for the 2021 update to the NFPA Technology Roadmap.

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